Coffee-farmers' empowerment in municipalities of Risaralda and Caldas through information technologies: A survey.

Empoderamiento de los caficultores en los municipios de Risaralda y Caldas a través de las tecnologías de la información: una encuesta.

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Abstract

Coffee cultivation is one of the mainstays for Colombian economy since it is known at international level due to its superb quality. In order to cultivate coffee, it is needed the existence of people and processes that allow them to obtain a top-notch product by using best practices. Also, it is necessary to talk about the empowerment that coffee-farmers have in order to improve, somewhat, the processes for their economic benefits to be greater, and how technology can contribute to this empowerment so that it grows and better results are achieved. The specialized literature in South America is limited in regard to the use of agriculture; however, some research in the south of Asia was found in the field of technology application in agriculture, and how the foregoing might support people's empowerment towards their crops. This job aims for acknowledging the level of coffee-farmers' empowerment that use information technologies in some municipalities of Risaralda and Caldas in Colombia. In order to fulfill that, some empowerment models of coffee-farmers were studied through technology, which were found in the academic literature. Then, the strongest model was selected and adjusted to the country's reality. The data were collected from a topographic survey, and the analysis was carried out by linear regressions in the statistical package STATA. The results were that the general farmers' empowerment was boosted with the age and education level of individuals. Besides, there is evidence of the presence of scale effects from different empowerment subtypes; for example, economic, social and familiar, as well as of knowledge and psychology.

Keywords: Agriculture, Empowerment, Information Technology.

1. Introduction

Colombia is a country that belongs to the third world. This means that it has a big competitive disadvantage in regard with developed countries, and this leads poverty to be demonstrated more significantly in an important part of the population. Coffee cultivation becomes an important economic option for several coffee-farmers inasmuch as the product quality is recognized worldwide. In order to fulfill the materialization of crop benefits, it is necessary to reach high efficiency levels. For this to happen, it is convenient to technify and implement technological tools in the productive processes (Blandón-Andrade, RamírezAristízabal, and Bedoya-Cadavid, 2020).

So as to achieve such technification and implementation levels of technological tools, it is necessary that the coffee-farmer owns a great level of empowerment. With the foregoing, the coffee-farmer seeks, somewhat, processes for their economic benefits to be enhanced as time goes by. In order to get to an optimum empowerment, technology can be used as a source of new knowledge, and it can become a relevant tool that, through scientific method, can turn empirical knowledge into viable and functional solutions for the farmers (Brooks, 1994). Thus, this becomes a means of enhancing their productive processes and therefore their life quality.

Thanks to technological progress, populations have more access to knowledge, thus developing their daily activities with greater agility and effeciency. The foregoing optimizes their time and resources. It is therefore a challenge for governments to further technological use in their settlers. It is necessary to analyze and comprehend how to measure the coffee farmers empowerment in some municipalities of Risaralda and Caldas through the information technologies considering the impact that these tools generate in the reinforcement of their duties and improvement in their life quality.

The upcoming paper is organized as it follows: the conceptual framework is introduced on the thematic axes in which the research is based on. Then, in the materials and methods part, the methodology used, data collection, and analysis techniques used are explained. Lastly, the obtained results, discussion and conclusions are introduced.

1.1. Conceptual Framework

Down below, a revision of the main three thematic axes from the current research is carried out: coffee cultivation, technology and empowerment.

Coffee cultivation

Coffee cultivation plays an important role in the Colombian economy. It is one of the responsible why the country has a strong presence in international markets, and it is internationally known due to the quality's product (Blandón-Andrade et al, 2020). Likewise, the foregoing is constituted in one of the most attractive productive alternatives for many farmer families because it gives an extra value to their lands (Federación Nacional de Cafeteros, 2017a).

It is crucial to highlight, at this point, that the coffee is a flagship product of the Colombian economy, from which 555.692 Colombian families get their livelihood

(Federación Nacional de Cafeteros, 2017b). This means that any effort research, in this strategic sector of the national economy, shall redound in benefits for the population. Moreover, the departments studied, Caldas and Risaralda, in this research, are alongside with Quindío those departments that compose the coffee region.

A concept that has gained momentum over the last years in coffee cultivation and other agricultural products has to deal with the Good Agricultural Practices (GAP) in accordance with Páez et al., (2012):

> It has been demonstrated that it is possible to reduce the use of pesticides by means of the accurate implementation of the BPA due to the fact that they are a strategy for agricultural production that guarantees sustainability and competitiveness. The aforementioned aims for producing agricultural goods, environmentally friendly taking into account the worker's health as well as the people who consume them. Producers and other factors from the agri-food chain must understand the importance to adapt them to the crops for expanding trade opportunities in the international field.

Finally, it is relevant to mention the concept of specialty coffees as one part of the cultivators that participated in the survey are specialty-coffees producers. This brings them economic benefits as additional premiums over production price, yet they have additional requirements in terms of their crops' technification and administration. The specialty coffees can be defined as:

> The consumer acknowledges quite particular characteristics by which he is willing to pay a higher price. These particularities can be related to organoleptic qualities of the infusion (highest quality coffee or special degree) with its unique source and constant quality (gourmet coffee), or with strict cultivation and/or marketing standards (sustainable coffee). (Castro, Contreras, Laca, & Nakamatsu, 2004)

It is also important to highlight the concept of bio-business. This approach might favor farmers' empowerment since it promotes economic and social impact as well as sustainable environmental practices. Molano cited by Albán, Pulido and Molano (2017) defines Bio-business as:

The economic process led to value's increase, tangible and intangible, by which the offeror and plaintiff of knowledge (public and private) are identified, interrelated and interacted, and from related products with biodiversity as well as biotechnology, in the frame of individual applications, entities and productive significative chains for a country.

Technology

It is important for human beings to enhance their life conditions. Because of that, they must evolve every day on how different activities are performed and through which they seek to meet their needs. Technology has currently become an indispensable tool because it counts with different devices and innovative systems that greatly contribute so as to facilitate many production processes or basic needs.

> Information and Communication Technologies (ICT) are those technologies that are needed for management and transformation of the information. They are also particularly required in the use of computers and programs that permit to create, modify, collect, protect and recover that information. […] Particularly, a social sense underlies the use of technology as long as it is associated with communication, human job in which inevitably social relationships are embedded. (Sanchez, 2008)

Bhatnagar and Schware (2000) mention that technology can be used for accelerating the development process since it contributes understanding, which was missed, or it speeds up fabrication processes. In other words, technology is one of the keys for optimizing resources and implementing efficient and quality programs. The foregoing is connected with the importance of emphasizing in production speed in order to be more competitive (Chakravarty, 2000). Technology contributes a type of cheaper and faster communication which represents an economic benefit,

thereby improving agricultural work and of marketing. This generates development for the country, and it is an efficient way to attack poverty (Aker & Mbiti, 2010).

Information and communications technologies (ICT) have within several concepts such as information systems, mobile devices, mobile applications, among others. An information system can be technically defined as a group of interrelated components that collect, feedback, process, store as well as distribute information as to support decision making, coordination, and control. Furthermore, information systems can even analyze problems caused by administrators and operators, visualize complex issues, and create brandnew products (Laudon & Laudon, 2014).

Mobile devices have evolved into the first personal computers, thus combining computational capacity with mobility and personalization. Unlike desk computers or even laptops, cell phones are always with their respective users, and they (cell phones) are ready to be used anytime (Jarvenpaa & Lang, 2005).

Mobile applications or apps are defined as "a software or an informatic program that is designed to function in smartphones, tablets and other mobile devices" (Martín, Fernández, & Yurrita, 2014, p.2). They are informatic tools that allow the user to perform different daily tasks through programs designed for being dynamic with the user in a fast and easy way, thus storing all the processed information in the devices and the cloud. The foregoing provides security and confidence in the new technologies.

Mobile applications might come already in the mobile devices, or they can be downloaded by the users in app mobile stores or the Internet. Furthermore, applications usually help users either connect with other Internet services commonly used in desk computers, or facilitate Internet use in their mobile devices (Wang, Liao, & Yang, 2013).

Empowerment

> The empowerment implies a certain type of community intervention, and of social change. This is based on the strengths, competencies, skills, and social support systems that promote transformation in the communities. Part of its appeal as a concept comes from the emphasis on the positive aspects of human behavior such as the identification and capacities' promotion as well as the well-being promotion rather than problem solution or identification of risk factors. […] In this way, the community becomes an active participant in the process of its own development (Perkins & Zimmerman, 1995)

Empowerment is understood then as the one in charge of fostering every human being dimensions, evaluating its capacities by providing a standard of living with greater sustainability. Each individual is willing to change, and a constant struggle for taking their life's control.

For analyzing empowerment, some models exist in the literature due to the fact that the concept changes according to the sociocultural context. Canval (1999) proposes that in order to determine the community empowerment, the following should be taken into account "to emphasize in the participation, attention, sharing, and responsibility. An empowered community is the one in which individuals as well as organizations gather abilities and resources in a collective effort so as to meet their needs".

Abdolmaleky's research (2012) proposes a sample of 330 farmers, who were randomly selected through sampling technique in diverse groups based on the characteristics of land use. Research design was carried out by a survey's design, which was divided into two sections. The first one was designed to collect personal data of every participant including the gender, the age, the income, time of work experience, level of education, etc. The second one

was designed to identify the satisfaction degree on their farm operations. The survey considered aspects such as: i) the size and kind of operations performed on the farms; ii) participation; iii) importance of the income that do not come from the farms; iv) the use of information technology; v) the perception regarding different statements; vi) marketing practices and research, and vii) the degree and need of education. The author sought the factors that affect the well-performance of the farmer's operations, and whether the technological use, as an empowerment strategy, helped increase productivity, which was indeed confirmed.

Ginige and Richards (2012) show another empowerment model, which was used for evaluating the farmers. They were empowered through technology, especially, with an agricultural system that facilitated farmer's operations. To conclude, farmers needed personalized information so that it can be useful for every user, and, through the empowerment presented model, activities are established to empower participants.

In another model, Rashig, Haque and Islam (2016) mention that the following variables should be taken into account: i) the change in economic empowerment that consists of the residual obtained income, money saving, investment, available loans, and consumable purchase; ii) the change in familiar and social empowerment that is considered by the contact evolution measures with the establishments, the partnerships that have with development departments, team spirit, leadership quality, group awareness for solving problems; and iii) the change in political empowerment, which is measured by the social activities participation, membership in social organizations, free expression and conflict management; iv) the change of knowledge empowerment, measured by team management, agricultural equipment, and BPA's implementation; v) the change in psychological empowerment, meausured by motivation increase for agriculture, self-esteem, taking risk hability, decision making

capacity and confidence. Lastly, the current study suggests that agricultural technology has an impact on farmer empowerment in Bangladesh (Southeast Asia).

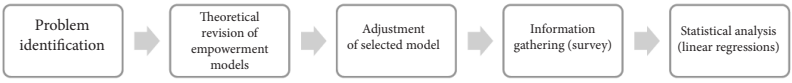
From the empowerment analyzed models, the current research takes the approach proposed by Rashid et al., (2016) as it includes categories that allow it to relate the technology development and use along with farmers empowerment; the aforementioned is at the same time a parsimonious model.

2. Materials and methods

2.1. Research Approach

The current research has a quantitative approach, which is the most appropriate to test theories (Hernández Sampieri, 2014). Within this approach, a topographic descriptive survey was carried out. The foregoing is oriented to understand the importance of such phenomenon and describe the distribution per se within a population (Forza, 2002). Its primary focus is not a theory development; however, through described facts, useful clues were found in theory construction and refining (Malhotra & Grover, 1998). Hence, the analysis of the collected data permitted to describe the relation between different empowerment types and the general farmers' empowerment. In figure 1, the research model used is shown.

Figure 1. *Estimation for social and familiar empowerment*



Problem identification – Theoretical revision of empowerment models – Adjustment of selected model – Information gathering (survey) – Statistical analysis (linear regressions).

The construction of farmer's empowerment is supported in four empowerment subtypes: economic empowerment; social and familiar empowerment; knowledge empowerment; and psychological empowerment, in which case the effects of the characteristics are observed on each of the empowerment previously mentioned. Thus, the general farmer empowerment is calculated by the following equation:

$$FE = EE + SFE + KE + PE$$

Where:
FE = Farmer's empowerment
EE = Economic empowerment
SFE = Social and familiar empowerment
KE = Knowledge empowerment
PE = Psychological empowerment

In agreement with the aforementioned, economic empowerment is calculated as the linear sum of the observed variables and graded from zero to five; therefore, the minimum value is zero, and the maximum value is twenty five in this category. The social and familiar empowerment is calculated as the linear sum of the components in a scale from one to five between each component, thereby the maximum number per individual is twenty. The knowledge empowerment is constructed by four components and a linear sum, so the lowest observed numbers per individual are zero, and the maximum ones would be fifteen. Finally, the psychological empowerment is calculated by three components and a linear aggregation of the observed results per individual whose values range between zero and fifteen.

Likewise, the observed characteristics of the 43 surveyed individuals will be taken as the independent variables in the estimated models of the different empowerment types. The following variables; age, education, land size, agriculture uses,

participation in organizations, cosmopolitanism, and agricultural availability, explain mean deviations from the different empowerment through five estimations.

Particularly in the sample, the education variable takes two different values; zero for illiterate people, and one for people with some primary school education. The size of the surveyed lands is 5,23 hectares and a maximum value of 32. Agricultural empowerment varies between 17 and 54 along the sample with a mean of 36,41. Economic empowerment varies between 0 and 16, with a mean of 7,67. Social and familiar empowerment varies between 2 and 12 with a mean of 7,79. Knowledge empowerment varies between 5 and 14 with a mean of 10,44. Lastly, Psychological empowerment varies between 5 and 15 with a mean of 10,51.

2.2. Data collection

Data collection was carried out through a survey. For this, an already valid document was adopted from the academic literature for the thematic axes previously mentioned (Rashid, 2014; Rashid eat al., 2016). It is important to highlight that some adjustments were carried out since the instrument application was developed in Bangladesh. Notwithstanding that Colombian farmer conditions matched with some points from southern farmers, some sociocultural conditions were necessary to be adapted for Colombian farmers.

The main adjustment that was carried out in regard to the research of Rashid et al,. (2014) was that the political empowerment was not included within the analyzed empowerment types. This was done in order to avoid any kind of controversy considering that the military conflict in the country has affected mainly the rural sector. Furthermore, in some empowerment categories, a few proposed variables were removed in the original instrument inasmuch as they did not apply for Colombian context. The adjusted instrument can be seen in the appendix 1.

The surveys were manually analyzed by one of the researchers so as to ensure that all the farmers had understood each one of the questions. The municipalities where the information was collected were Apia and Santa Rosa (Risaralda) as well as Viterbo (Caldas). It is crucial to highlight that despite the fact that the information was gathered in these geographic places, some of the participants belonged to other municipalities of the two departments previously mentioned. Considering cultural, economic and social similarities between the departments of the Colombian coffee region, that did not whatsoever affect the results obtained in the survey. In total, 50 responses were obtained; however, only 43 responses were actually used. The other 7 were discarded due to the lack of some data.

It is also relevant to mention that, although the people involved were not asked to sign an informed consent, they were told, before asking the respective questions, that their participation was voluntary, and the information would only be used for academic purposes.

2.3. Data analysis

For the collected data analysis, five linear regressions were carried out on the four empowerment subtypes: (1) economic, (2) social and familiar, (3), knowledge and (4) psychological. The fifth regression was performed on the influence of the observed characteristics on the general farmers' empowerment level. In order to carry out these regressions, the statistical STATA package was used.

3. Results and discussion

The relation between the independent variables and agricultural empowerment is expected to cause a significantly statistical-linear-regression model that capture the expected effects of the independent variables on the empowerment results. With

a partial correlation analysis, a priori, the following factors; age; education; listening to radio programs about agriculture; watching TV programs about agriculture; attitude towards electronic agriculture; and participation in organizations are expected to have positive effects on farmer empowerment. However, other factors such as localization and the type of land are expected to have negative effects as observed variables present a higher value.

In the framework of economic empowerment, positive correlations with age; education, land size; listening to agricultural radio programs; looking up information in the Internet about agriculture; attitude towards electronic agriculture; electronic agriculture availability; and other empowerment types such as the economic and the psychological one are evidenced. However, there is a negative correlation towards the land type and cosmopolitanism level.

For social and economic empowerment, a high positive correlation with land type, watching television programs about agriculture, attitude towards electronic agriculture, participation in organizations, and other empowerment types as the ones of knowledge and psychological is observed. Nonetheless, a negative high correlation exists towards localization; land size; use of technology; and electronic agricultural availability.

On the other hand, in knowledge empowerment a positive correlation was obtained towards education; land size; use of the cell phone in agricultural jobs; watching television programs about agriculture; attitude towards electronic agriculture; participation in organizations and other empowerment types as the economic; social, familiar and psychological. A negative correlation was obtained in regard to age; localization; land type and Internet consultation of agricultural information.

Lastly, in psychological empowerment a positive correlation is observed in relation with the use of technology; attitude towards

electronic agriculture; participation in organizations; and other empowerment types such as the economic; social, familiar and of knowledge.

3.1. Estimations

The dependent variable is taken as the empowerment indicator that is explained by the observed agricultural characteristics. That is to say, 5 linear regression models are made in order to capture partial effects of the observed individual characteristics towards the agricultural empowerment level, the 4 subtypes, economic empowerment level, social and familiar empowerment level, knowledge empowerment level as well as psychological empowerment level5. The results for the farmer empowerment are shown in figure 2.

Figure 2. *Farmer's empowerment estimation*

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      Source |       SS           df       MS      Number of obs   =        43
-------------+----------------------------------   F(6, 36)        =      3.86
       Model |  952.348739         6   158.72479   Prob > F        =    0.0045
    Residual |  1482.11638        36  41.1698994   R-squared       =    0.3912
-------------+----------------------------------   Adj R-squared   =    0.2897
       Total |  2434.46512        42  57.9634551   Root MSE        =    6.4164

------------------------------------------------------------------------------
          ea |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       edad2 |  -.0022944   .0014403    -1.59   0.120    -.0052155    .0006266
localización |  -7.597792   3.184091    -2.39   0.022    -14.05543   -1.140157
  tipopredio |  -2.822658   1.741999    -1.62   0.114    -6.355596    .7102804
           K |   3.282772   1.845222     1.78   0.084    -.4595105    7.025055
           M |   5.442908   1.635831     3.33   0.002     2.125288    8.760527
        eedd |   .2357446   .1226923     1.92   0.063    -.0130869     .484576
       _cons |   26.27395   6.967424     3.77   0.001     12.14335    40.40454
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Edad2: age2
Localización: location
Tipo predio: land-type

It can be inferred that farmer's empowerment has a direct relation with listening radio programs about agriculture, K variable, and watching television programs about agriculture, variable M. On the other hand, the education product along with

the age, variable eedd, evidences that there is a booster effect in education population as the individual is getting older. On the contrary, as the individual shares the property or the crop shows a less empowerment degree, which strengthens the idea of a reinforced individualism with low willingness levels to the cooperation. In the table 1, the estimate summary is shown for each one of the empowerment subtypes, and in the appendix 2, estimates results are shown in detail.

Table [5]. *Estimates summary for each empowerment subtype*

Estimaciones empoderamiento económico						
var. dep.	edad	edad2	K	ec	dispon. ea	constante
coeficiente	0,560092	-0,0044	1,936893	0,594993	1,089852	-19,6095
p-valor>|t|	0,024	0,067	0,022	0,021	0,003	0,003
R^2	0,4862					
p-valor>|F|	0,0001					

Estimaciones empoderamiento social y familiar						
var. dep.	eedd	tamaño	tipopredio	L	ee	constante
coeficiente	-0,03806	-0,17988	1,381141	-0,71528	0,314556	5,967995
p-valor>|t|	0,202	0,038	0,031	0,14	0,004	0,039
R^2	0,3736					
p-valor>|F|	0,0030					

Estimaciones empoderamiento de conocimiento								
var. dep.	eedd	tamaño	tipopredio	usoea	N	esf	edad	constante
coeficiente	0,055521	0,138559	-1,15545	1,659761	-1,0572	0,431557	-0,08836	9,593876
p-valor>|t|	0,055	0,022	0,006	0,047	0,003	0,000	0,010	0,000
R^2	0,5732							
p-valor>|F|	0,0000							

Estimaciones empoderamiento psicológico			
var. dep.	M	ec	constante
coeficiente	1,272826	0,379488	4,358626
p-valor>|t|	0,006	0,009	0,004
R^2	0,3772		
p-valor>|F|	0,0001		

Economic empowerment estimation
var. dep: dependent variable (dep var); age; age 2; K; ec; dispon.ea (availability fe), constant
Social and familiar empowerment estimation
Var. dep: dependent variable (dep var); eedd; size, land type, ee, constant.
Knowledge empowerment estimation
Var. dep: dependent variable (dep var); eedd; size, land type; usoea (use of FE); esf; age; constant
Psychological empowerment estimation
Dep.var; M;ec; constant

5 . From the test for heteroscedasticity, Breush-Pagan, null hypothesis rejection for Heteroscedasticity in all estimated models is evidenced. Also, those variables that do not contribute to explain average behavior of the dependent variable through T-test of individual significance are discarded.

Efaconomic empowerment increases as the following factors take place; the individual gets older[6], listens to radio programs about agriculture, and has a higher willingness at the use and acquisition of electronic resources for agricultural activities, see table 1 and figue 3 from the appendix.

In the social and familiar empowerment, there is evidence that the farmers have less empowerment levels as their land becomes bigger. Nonetheless, social and familiar empowerment increases when it cooperates, or has shared ownership from the land or the harvest. On the other hand, there is no sufficient evidence on the real effect of the cell phone use and education product along with the age in empowerment social and familiar level. That can be appreciated in table 1 and the figure 4 from appendix 2.

Knowledge empowerment is expected to increase its average value when the land increases its size, people are more educated as they get older, and use technology. On the other hand, the knowledge empowerment reduces Internet consultation, and it shares the property of the land or the harvest and with the age. That can be appreciated in table 1 and figure 5 from appendix 2.

Finally, psychological empowerment increases as farmers use their cell phones in agricultural activities. This is evidenced since the variable partially explains average variations in psychological empowerment, see table 1 and figure 6 in the appendix 2. There is no sufficient statistical evidence to infer the presence or absence of other observed socioeconomical characteristics on the psychological empowerment level.

Furthermore, there is a positive relation between the four categories of empowerment. If one category is developed, the expectation is that the other categories are increased, too. In this way, the economic empowerment is boosted by knowledge empowerment. Social and familiar empowerment has positive

6 Nonetheless, the increase will be decreasing as years go by.

effects of increases in the economic empowerment. Knowledge empowerment has a direct and positive relation with the social and familiar empowerment, and psychological empowerment has positive effects of the increases in knowledge empowerment.

4. Conclusions

In the general farmer's empowerment, the momentum is reinforced on the multimedia content in order to increase the empowerment level of the coffee producers. The boosting education effect with the age requires the public policies rout on education of the adult and valid population, from the theories of the human capital, the early education with long-term effects.

In economic empowerment, further studies are expected to ensure the relation between financial capacity and economic empowerment, thereby understanding the capacity as the finance knowledge and the access to financial services from the development perspective.

On the other hand, the increase in the land size has a negative relation with the social and familiar empowerment level, whereas such relation is positive with knowledge empowerment. This situation can indicate that bigger land's administration requires more qualification and thus might induce social isolation as it requires more work and dedication.

Considering psychological empowerment, the values of the associated coefficients with the cell phone use and knowledge empowerment, which explain psychological empowerment, are positive and promote to deepen in the direction of causality among these variables. Hence, farmer's motivation and fulfillment, through agricultural work, can be in favor to technological information access and communication as a means of cultural, social and productive linkages as was pointed out by Aker and Mbiti (2010), Ginige and Richards (2012).

By considering the average age of the surveyed farmers, 50 years old, the proposal consists in harnessing the generational replacement with incentives to the construction and maintenance of agricultural empowerment. Thus and through this study, the needs are identified in the community that address public policy; for instance, the use of TIC in agricultural activities that promote motivation and fulfillment of young farmers, access to technical information through media, education strategies that enable autonomous learning and access to financial services.

Finally, the positive relations between the different empowerment categories are established, but it is not possible to establish causality relations among the aforementioned. There should be required to explore the connection between the categories that can understand scale effects or positive externalities for targeting resources, in terms of public policy, efficiently in the development of a categories subset. Also, there is a recommendation in future research to carry out bio-business plans with the farmers, as mentioned in the theoretical framework, this approach can favor the empowerment since it promotes social impact and environmental conservation.

References

Abdolmaleky, M. (2012). Preconditions of small-farmers' empowerment to success in farm operations in lorestan province, Iran. *World Applied Sciences Journal*, *19*(4), 523–529.
https://doi.org/10.5829/idosi.wasj.2012.19.04.2061

Aker, J. C., & Mbiti, I. M. (2010). Mobile Phones and Economic Development in Africa. *Mobile Phones and Economic Development in Africa*, (June 2010), 1–43. https://doi.org/10.1257/jep.24.3.207

Albán, I. A., Pulido, M. A., & Molano, J. H. (2017). Bionegocios, un sendero para el desarrollo. *Revista Colombiana de Biotecnologia*, *Número Esp*, 35–37. https://doi.org/10.1017/CBO9781107415324.004

Bhatnagar, S., & Schware, R. (2000). Information and communication technology in rural development. Case Studies From India, World Bank Institute, 1–192. Retrieved from http://wwwwds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2007/03/08/000310607_20070308122818/Rendered/PDF/389200Info0and1cation0200001PUBLIC1.pdf

Blandón-Andrade, J. C., Ramírez-Aristizábal, C., & Bedoya-Cadavid, J. A. (2020). Necesidades de gestión de la información en una App para caficultores : un estudio de caso. Aibi Revista de Investigación, Administración e Ingenieria, 8(2), 39–46.

Brooks, H. (1994). The relationship between science and technology. *Research Policy*, *23*, 477–486.

Canaval, G. E. (1999). Propiedades psicométricas de una escala para medir percepción del empoderamiento comunitario en mujeres. *Colombia Medica*, *30*(2), 69–73.

Castro, P., Contreras, Y., Laca, D., & Nakamatsu, K. (2004). Café de especialidad: alternativa para el sector cafetalero peruano. *Esan-Cuadernos de Difusión*, *9*(17), 1–24. Retrieved from file:///C:/Users/Lina/Downloads/166-168-1-PB.pdf

Chakravarty, R. (2000). IT at Milk Collection Centers in Cooperative Dairies : The National Dairy Development Board Experience. *Information and Communication Technology in Development: Cases from India*, 37–47.

Federación Nacional de Cafeteros. (2017a). Avancemos en la estrategia de rentabilidad del caficultor. *85 Congreso Nacional de Cafeteros*, 40. Retrieved from https://www.federaciondecafeteros.org/static/files/Periodico_CNC2017.pdf Federación Nacional de Cafeteros. (2017b). La Federación en Cifras.

Forza, C. (2002). Survey research in operations management: a process based perspective. *International Journal of Operations & Production Management*, *22*(2), 152–194. https://doi.org/10.1108/01443570210414310

Ginige, T., & Richards, D. (2012). A model for enhancing empowerment in farmers using mobile based information system. In *ACIS 2012 : Proceedings of the 23rd Australasian Conference on Information Systems* (pp. 1–10).

Hernández Sampieri, R. (2014). *Metodología de la Investigación* (6th ed.). Mc Graw-Hill. https://doi.org/10.1017/CBO9781107415324.004

Jarvenpaa, S. L., & Lang, K. R. (2005). Managing the paradoxes of mobile technology. *Information Systems Management*, *22*(4), 7–23. https://doi.org/10.1201/1078.10580530/45520.22.4.20050901/90026.2

Laudon, K. C., & Laudon, J. P. (2014). *Management Information Systems* (14th ed.). Edinbugh: Pearson.

Malhotra, M. K., & Grover, V. (1998). An assessment of survey research in POM: From constructs to theory. *Journal of Operations Management*, *16*(4), 407–425. https://doi.org/10.1016/s0272-6963(98)00021-7

Martín, I. S. M., Fernández, M. G., & Yurrita, L. C. (2014). Aplicaciones móviles en nutrición, dietética y hábitos saludables; análisis y consecuencia de una tendencia a la alza. *Nutricion Hospitalaria*, *30*(1), 15–24. https://doi.org/10.3305/nh.2014.30.1.7398

Páez M, M. I., Varona Uribe, M., Díaz, S. M., Castro, R. A., Barbosa, E., Carvajal, N., &

Londoño, A. (2012). Evaluación de Riesgo en Humanos por Plaguicidas en Tomate

Cultivado con Sistemas Tradicional y BPA (Buenas Prácticas Agrícolas). *Revista de Ciencias*, *15*, 153–166. https://doi.org/10.25100/rc.v15i0.523

Perkins, D. D., & Zimmerman, M. A. (1995). Empowerment Theory, Research, and Application. *American Journal of Community Psychology*, *23*(5), 569–579.

Rashid, S. M. M. (2014). *Empowering Farmers Through e-agriculture*. Sher-E-Bangla Agricultural University.

Rashid, S. M. M., Haque, M., & Islam, R. (2016). Does e-agriculture impact on farmers' empowerment in Bangladesh? *International Journal of Agricultural Extension*, *4*(1), 87–94.

Sanchez, E. (2008). Las Teccnologías de Información y Comunicación desde una Perspectiva Social. *Educare*, *182*(7), 52–53.

Wang, H.-Y., Liao, C., & Yang, L.-H. (2013). What Affects Mobile Application Use? The Roles of Consumption Values. *International Journal of Marketing Studies*, *5*(